Remarks on the Succession of Bryophytes on Hawaiian Lava Flows

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The Hawaiian Islands are well known for their volcanic origin and for continuing volcanic activity on the largest island, Hawaii. On May 13, 1955, Hawaii experienced a volcanic eruption and lava flow of considerable magnitude. Professor Maxwell Doty undertook a series of surveys to outline the plant succession on this new flow.[2]

The first bryophyte was observed and collected at about a 950-ft. elevation on December 20, 1955, when a tiny juvenile colony of *Campylopus introflexus* (perhaps *C. boswelli,* though this species was not collected later) was discovered in the folds of lava blisters. A substantial portion of the collection was sent to me in half of a foil chewing-gum wrapper—which indicates the extreme youth of the colony. The individual plants were 3–5 mm. high, or about the length of 1½ leaves. On February 22, 1956, *Campylopus densifolius,* in about the same stage of development as the first moss collected, was taken at about 900 ft., in the Kamaili Homesteads at Puna. In late March more colonies of *C. densifolius* were discovered on the Iilewa flow, and *C. exasperatus* was discovered growing on old lava adjacent to the new flow. Specimens of apparently living *Macromitrium owahiense* were collected from the bark of a *Metrosideros* (*Ohia lehua*) tree which had been killed by the encroachment of hot lava. In August, *Campylopus introflexus* was found on the flow about ½ mi. east of McKenzie Park. In subsequent collections this species seemed to be established in several places on the new flow. Two species previously unrecorded for the Iilewa flow were discovered at about 950 ft. in April, 1957, and *Rhacopilum cuspidigerum* and *Rhacomitrium lanuginosum* var. *pruinosum* were added to the growing list of pioneer bryophytes. The December, 1958, collections contained *Campylopus exasperatus* and *Funaria hygrometrica,* along with species previously found on the flows.

In general, exposed lava flows support few species of bryophytes and these are restricted to protected crevices or small shaded niches. The several species of *Campylopus* establish themselves rather readily in lava under climatic conditions of the type favorable for the growth of *Metrosideros.* It is of interest that *Campylopus fumarioli* becomes established in the steam fissures at Kilauea. In Hawaii, species of *Campylopus* appear to play a significant pioneer role in rock succession and are often found on rocks devoid of other plants. *Rhacopilum cuspidigerum* is the most ubiquitous moss in Hawaii and with its obviously great range of tolerance would be expected to be a pioneer species on new lava as well as on older rocks. It produces an abundance of spores throughout the year, which is another factor favoring rather rapid establishment in unoccupied habitats in frost-free regions.

Rhacomitrium lanuginosum var. *pruinosum* has a much greater altitudinal range than *Rhacopilum* and is found in more exposed situations. The upper half of each leaf is hyaline and the striking silver-grey tufts of *Rhacomitrium* can be easily seen and recognized. Above 8,000 ft. on the barren lava flows of Mauna Loa this species of *Rhacomitrium* and *Grimmia trichophylla* are the only plants to be found. I have collected both of these mosses on the unexposed sides of lava clinkers at 11,000 ft. The *Rhacomitrium* has been collected at the summit of Mauna Loa by several people. In spite of its great tolerance of seemingly arid conditions, *Rhacomitrium* plays an important role in bog formation in the Alakai Swamp on Kauai. It is suggested that the acid nature of the bog may represent a physiologically, though not physically, arid habitat with the cloud moisture

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characteristic of mountain tops. Comparative physiological studies of several populations would be most interesting in this regard.

The species of *Campylopus, Rhacopilum, Rhacomitrium,* and *Grimmia* previously mentioned are true pioneers which establish themselves on bare lava rock. However, other mosses appear on relatively new lava flows in pockets where dust collects to form a minute patch of soil. The plants which colonize this type of microhabitat are mosses of world-wide distribution which might aptly be called "weeds." *Funaria hygrometrica* is the only such species found in Doty's collections, although *Bryum argenteum* and *Ceratodon purpureus* have been found on essentially barren lava flows in similar circumstances.

The classical concept of lichen–moss–herb–shrub–tree succession does not apply in Hawaii on new lava flows. Mosses are true rock pioneers and lichens are rather limited in their establishment. In general, a few species of bryophytes become established in suitable microhabitats and never form an extremely conspicuous part of the vegetation. In fact, it would seem to one who has observed Hawaiian lava flows that plants are established wherever and whenever suitable habitats exist for the disseminules which reach these habitats. Thus, no exact plant succession of one plant replacing another can be established. With the establishment of vascular plants, new microhabitats become available and such moss species as *Macromitrium brevisetum, M. emersulum, Fissidens* spp., *Bryum* spp., *Pohlia* spp., *Ectropothecium sandwichense,* and *Vesicularia graminicolor* become established on rock in mesophytic regions. Often the leafy liverwort *Brachiolejeunea sandvicensis* becomes established at the same time as the mosses listed above. Another liverwort, *Riccia rechingeri,* was recently discovered in soil pockets in the Kau desert and may be discovered in similar habitats on newer flows. As soil is necessary for the growth of this plant, it probably should not be considered a true pioneer species.